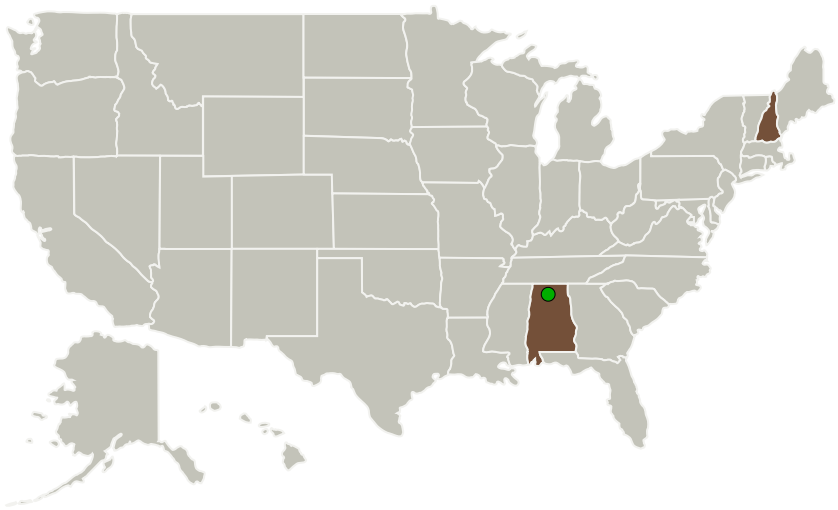
A High Efficiency Cryocooler for In-Space Cryogenic Propellant Storage, Phase II

Completed Technology Project (2017 - 2019)

Project Introduction

NASA is considering multiple missions involving long-term cryogen storage in space. Liquid hydrogen and liquid oxygen are the typical cryogens as they provide the highest specific impulse of practical chemical propellants. These cryogens are stored at temperatures of nominally 20 K for hydrogen and 90 K for oxygen. Due to the large size of these tanks, refrigeration loads to maintain zero-boil-off are high, on the order of tens of watts at 20 K and hundreds of watts at 90 K. Space cryocoolers have been developed for cooling space sensors that have modest cooling loads and are not suitable for high capacity applications. On this program, we proposed to develop a high capacity turbo-Brayton cryocooler that provides 150 W of refrigeration at 90 K. On the Phase I project, we developed a preliminary design of the 90 K cryocooler, assessing its size, mass, performance, and maturity. The proposed cryocooler significantly exceeds the performance targets set forth in the solicitation -- the cryocooler specific power is only 8 W/W (solicitation goal of 15 W/W), and the specific mass is 0.4 kg/W (solicitation goal of 12 kg/W). On the Phase II project, we propose to develop and demonstrate the least mature components, the compressor and its inverter drive. On a future Phase III project, we plan to build and demonstrate an engineering model cryocooler. Successful completion of this project fills a clear void in space cryocooler technology.

Primary U.S. Work Locations and Key Partners



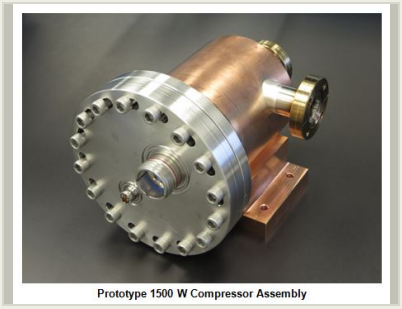


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Table of Contents

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
Creare LLC	Lead Organization	Industry	Hanover, New Hampshire
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	New Hampshire

Project Transitions

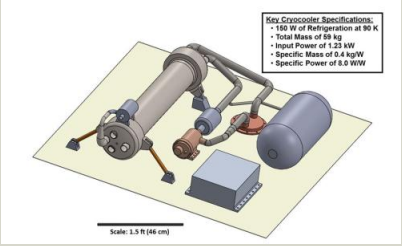
May 2017: Project Start

April 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141097)*

Images



Briefing Chart Image
A High Efficiency Cryocooler for In-Space Cryogenic Propellant Storage, Phase II Briefing Chart Image *(https://techport.nasa.gov/image/127112)*

Final Summary Chart Image
A High Efficiency Cryocooler for In-Space Cryogenic Propellant Storage, Phase II *(https://techport.nasa.gov/image/133027)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Creare LLC

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

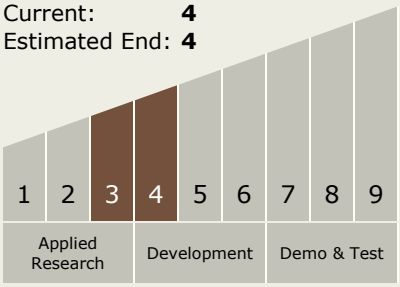
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Mark Zagarola

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.3 Cryogenic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System